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# GENERAL ACTIVITY AND REPRODUCTIVE BEHAVIOR OF *RHAGOLETIS CORNIVORA* (DIPTERA: TEPHRITIDAE) FLIES IN NATURE

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*Abstract.*—Data from field observations on the location and activity of *Rhagoletis cornivora* Bush flies on *Cornus amomum* Mill. revealed the following. Females made more visits to each of fruit, leaves, and branches than did males. Females fed while on the upper surface of leaves and much more often than did males. While females spent almost as much time on leaves as they did on fruit searching for suitable oviposition sites, males spent most of their time on fruit clusters, either searching or waiting for potential mates. Most encounters between flies occurred on fruit. Males mounted other males as often as they did females, indicating the inability of males to distinguish between the sexes. Unripe fruit were preferred over ripe ones for oviposition.

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The family Tephritidae (Insecta: Diptera) comprises many species of flies whose larvae feed in the flesh of growing fruits or vegetative tissues and often constitute major agricultural pests. Members of the genus *Rhagoletis* infest a broad range of fruits, including cherry and walnut. The four members of the *pomonella* species group are so morphologically similar that originally they were considered to be "host races," or biotypes, of a single species (Pickett, 1937), each feeding solely on plants in a different family: *R. pomonella* (Walsh) on apple, hawthorn, plum, cherry, and rose hips (Rosaceae); *R. mendax* Curran on blueberry (Ericaceae); *R. zephyria* Snow on snowberry (Caprifoliaceae); and *R. cornivora* on dogwood (Cornaceae). Ecological (see Bush, 1966; Boller and Prokopy, 1976, and references therein) and biochemical (Simon, 1969; Berlocher, 1980; Berlocher and Bush, 1982) studies have shown these four flies to be distinct species. Although the natural history and behavior of the economically-important *R. pomonella* (Prokopy et al., 1972; Dean and Chapman, 1973; Reissig and Smith, 1978; Smith and Prokopy, 1980) and *R. mendax* (Lathrop and Nickels, 1932; Smith and Prokopy, 1981, 1982) flies have been well studied, little is known about the other two species. Here, I present the results of observations of *R. cornivora* adult activity in nature.

## MATERIALS AND METHODS

This study was conducted during the summer of 1981 in Champaign, Illinois. *R. cornivora* behavior was observed on a group of five heavily-fruiting silky dogwood bushes that reached 2 m in height. Data were collected between 0900 and 1300 hours CST on each sunny or partly sunny day from 7 to 12 August, beginning four days after the first fly sighting.

Flies were selected randomly by blindly pointing at a branch and watching the fly closest to the selected spot. Flies were watched for as long as they remained in view, up to a maximum of five minutes. I watched each fly from ca. 30 cm away. As long

Table 1. *R. cornivora* visits and time[a,b] spent on silky dogwood plant parts by 41 males and 62 females.

| Sex | Location | No. of visits | Total time | Mean time/visit | Mean total time/fly |
|---|---|---|---|---|---|
| Male | Fruit | 96 | 7,112 | 74a | 173a |
| | Leaves | 53 | 997 | 19b | 24b |
| | Branches | 7 | 22 | 3c | 1c |
| Female | Fruit | 425 | 5,840 | 14b | 94d |
| | Leaves | 266 | 4,820 | 18b | 78d |
| | Branches | 21 | 106 | 5c | 2c |

[a] In seconds; maximum 300 sec per fly.

[b] Any 2 means in each column followed by the same letter are not significantly different at the 5% level using Student *t*-test.

as I avoided sudden movement, my presence did not appear to affect fly behavior. Fly activities were recorded verbally on tape and later transcribed for analysis.

Fly activities were defined as follows: feeding was lowering the proboscis to touch the surface on which the fly was situated; an encounter was a meeting of two flies in which there appeared to be recognition by each fly of the other's presence; mounting was a male attempting copulation with another fly by flying or leaping onto its abdomen; boring was insertion of the ovipositor into a fruit; and oviposition was deposition of an egg as evidenced by subsequent ovipositor dragging (Prokopy et al., 1976).

On 10 August, 80 fruit clusters were randomly chosen, in the same manner as the flies, and inspected on the bush to determine the relative numbers of fruit available to the flies for each of three categories of maturity, as judged by skin color. *C. amomum* fruit changed from green to green-blue to blue.

Statements of comparison are supported by chi-square or Student's *t*-test.

## RESULTS

The activities of 41 males and 62 females were observed. Table 1 gives the number and duration of visits to plant parts by each sex. Males moved among plant parts less often than did females. Most male time was spent on fruit, as reflected both by the larger number of visits ($\chi^2 = 11.8$, $P < 0.005$) to and by the greater time spent per visit ($t = 5.68$, $P < 0.001$) on fruit compared with leaves. Females also made more visits ($\chi^2 = 36.13$, $P < 0.005$) to and spent more total time ($\chi^2 = 97.4$, $P < 0.005$) on fruit than on leaves. Neither sex spent much time on branches. Nine males, but no females, spent the full five minute observation period on an individual fruit. No fly remained this long on a leaf. Although females visited more fruit than did males, males spent more time there since the mean length of visit was much greater ($t = 6.51$, $P < 0.001$) than for females. Females spent more time on leaves than did males ($t = 3.28$, $P < 0.005$). The mean observation periods for males and females were 198 sec (SD 108) and 174 sec (SD 110), respectively.

All feeding occurred while on the upper surface of leaves, where flies found substances resembling insect honeydew in one male and 25 female visits.

A total of nine male–female encounters was observed. Both encounters on leaves began with the flies facing one another and led to a short flight or leap by the male onto the female, resulting in mating. In all encounters on fruit, the female apparently was searching the fruit for a suitable oviposition site. Five of the seven encounters there led to mounting and two of these resulted in mating, both of which began with a male making a rear approach to a female while she was boring into the fruit. The male approached the female from the front in the two encounters that did not lead to mounting. The male approached from the rear or side in the three mounts that did not lead to mating. Whether on a leaf or fruit, no female approached a male. Whenever mounting did not occur, it was the female who left first. During those mounts that did not result in mating, the female repeatedly lifted her wings and sharply turned her body in an apparent effort to dislodge the male. This female resistance did not occur during mounts which led to mating.

One encounter between females occurred on a fruit and both flew away. Male–male encounters were mostly on fruit. Mounting occurred after four of five encounters on fruit and after the one on a leaf. The two males were head-to-head before all of these mounts. There was no apparent recognition by the mounting fly that the mounted one was another male, especially since two males were dislodged, by movements similar to those of resisting females, and then tried to remount.

Only 5.2% of female visits to fruit led to oviposition. Boring without egg deposition occurred in 1.4% of visits. Before boring, a female usually walked around the fruit for several seconds, apparently searching for a suitable oviposition site. Upon finding one, she held her upraised body with the tip of the abdomen nearly touching the surface, extended the ovipositor to it and pumped the abdomen up and down several times until the fruit skin was punctured. Oviposition took a half to several minutes. Almost immediately afterward, she walked rapidly around the fruit several times while dragging the extended ovipositor on the fruit surface. When finished dragging, she cleaned the ovipositor for several seconds with the metathoracic legs and then left the fruit. Often this cleaning continued at another site. Although some females bored more than once per visit, they did not oviposit more than once. Females preferred green fruit to riper fruit for oviposition ($\chi^2 = 7.68$, $P < 0.01$). They deposited an egg in 18 of 24 green, 3 of 3 green-blue, and the 1 blue fruit into which they bored. The percentages of these fruit types on the bushes were 55, 23, and 22, respectively.

## DISCUSSION

The general activity pattern of *R. cornivora* flies was similar to that of *R. mendax* (Smith and Prokopy, 1981) and *R. cingulata* (Smith, 1984). Females search for food and oviposition sites while males wait on fruit for approaching females. As in some other *Rhagoletis* species (Prokopy, 1976; Webster et al., 1979; Smith and Prokopy, 1981), *R. cornivora* females fed more often than males. They are larger than males (Middlekauff, 1941) and presumably need more energy to sustain greater activity and biomass and more protein to produce mature eggs. However, it is unclear why males appeared to feed so seldom. Perhaps, as in *R. mendax* (Smith and Prokopy, 1981), most male feeding occurred early or late in the day and therefore was not observed in this study. Also, *R. mendax* (Smith and Prokopy, 1981) and *R. cingulata* (Smith, 1984) males fed most often on the juice of damaged fruit. Damaged dogwood

fruit were scarce, thus depriving *R. cornivora* males of a ready food source while they were perched on fruit and watching for foraging females.

The mating behavior of *Rhagoletis* flies seems to follow a common pattern. Females are receptive to mating while on leaves, usually when ovarially-immature and not yet ovipositing, but not while on fruit, where they often are force-mated while engaged in some form of oviposition behavior and unable to resist a mounting male, especially when the ovipositor is exposed. This appears true for *R. pomonella* (Smith and Prokopy, 1980), *R. mendax* (Smith and Prokopy, 1982), *R. cingulata* (Smith, 1984), and now for *R. cornivora.*

In common with *R. cingulata* (Smith, 1984), *R. cornivora* females chose unripe over ripe fruit for oviposition. This preference may be advantageous if fully mature fruit do not fulfill the nutritional requirements of the larvae or if ripe fruit are more likely than unripe ones to drop to the ground and then rot or desiccate before the larvae are fully developed.

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